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Ergometer-cycling with strict versus minimal contact supervision among the oldest adults: a cluster-randomised controlled trial

Author names:

Evelien Van Roie*[1], Sofie Martien*[1], Emalie Hurkmans[1], Johan Pelssers[1], Jan Seghers[1], Filip Boen[1], Christophe Delecluse[1]

*contributed equally to the manuscript

Author affiliations:

[1]KU Leuven, Department of Kinesiology, Physical Activity, Sports and Health Research Group, Tervuursevest 101, 3001 Leuven (Belgium)

Corresponding author:

Evelien Van Roie

Address: Tervuursevest 101, 3001 Leuven (Belgium)

Telephone number: 0032 16 379431, Fax number: 0032 16 329197

E-mail: evelien.vanroie@kuleuven.be

HIGHLIGHTS

- Ergometer-cycling with minimal coach-supervision is feasible in residential homes.
- Autonomy support does not result in better long-term adherence rates.
- High adherers show positive but small effects on physical and muscular function.

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ABSTRACT

Objective To evaluate the feasibility and short- and long-term effects of two 10-wk structured ergometer-cycling programs among elderly in assisted-living residences.

Design, setting, and participants Eight assisted-living residences (N = 95; age = 81.2 ± 5.9 years) were randomly assigned to one of three conditions: 1) ergometer-cycling with strict coach-supervision (STRICT, N = 3; *n* = 35); 2) ergometer-cycling with autonomy-supportive minimal contact coach-supervision (AUT; N = 3; *n* = 36); or 3) control condition (CON; N = 2, *n* = 24).

Intervention Three-weekly progressive ergometer-cycling sessions for 10 weeks.

Main outcome measures Feasibility, physical activity (PA), muscular strength, functional performance and quality of life (baseline, post-intervention (10weeks) and 6-month follow-up).

Results 83 participants were analyzed post-intervention, 75 at follow-up. Adherence was higher in STRICT than AUT during the intervention ($p = 0.001$), but not during follow-up. Compared with CON, both programs showed positive short- and long-term effects on moderate-intensity PA ($p = 0.034$). With regard to strength, functional performance and well-being, no time-by-group interaction effects were found. When comparing high-adherers (adherence ≥ 80%) to low-adherers, a greater increase in functional performance and in well-being and a trend towards a lower decrease in strength were found in the short-term ($p = 0.047$, $p < 0.001$ and $p = 0.054$, respectively).

Conclusion Both interventions were feasible and equally effective to increase long-term engagement in PA, irrespective of the type of supervision. When adherence is high, positive effects on strength, performance and well-being can be expected.

Trial registration Clinical Trials NCT01748461.

Keywords: Aging; Physical activity; Adherence; Maintenance; Supervision

HIGHLIGHTS

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1. INTRODUCTION

Populations around the world are aging rapidly, and the fastest growing segments are the old (75-84 years) and the old-old (≥ 85 years) (Christensen et al., 2009). Aging is characterized by declines in physical fitness and strength, which diminish physical functioning and therein threaten independency (Spirduso, 2005). Therefore, retaining physical functionality is essential to maintain a worthwhile quality of life at older age.

Regular physical activity (PA) can attenuate the maladaptive impact of aging, but the majority of older adults are insufficiently physically active to maintain their present physical functionality level (Sjöström et al., 2006; Varo et al., 2003). Moreover, PA involvement progressively diminishes with increasing age (Buchman et al., 2014), which stresses the importance of PA promotion among older adults in public health policy.

In community-dwelling older adults, regular PA has been shown to delay the physical disablement process, which is characterized by reduced muscular strength and a loss of daily functioning (Pahor et al., 2014; Tak et al., 2013). However, individuals who have the most potential to improve physical functioning are probably those who have just entered the early stages of physical impairment. In the last two decades, assisted-living residences have become a popular housing option for older adults who experience some difficulty in daily life activities (Giuliani et al., 2008; Schulz et al., 2006). Assisted-living residences provide a combination of housing, personalized supportive services and health care to assist older adults in coping with daily life demands. Personalized support can include assistance with medication, meal preparation and access to medical care. In addition, social and recreational activities are provided to the residents (Tighe et al., 2008). In contrast with nursing home residents who are supervised during the whole day, assisted-living residents live independently. Support is only provided when required. Assisted living is often viewed as temporary to delay the definite referral to a nursing home. However, it is currently unclear whether increasing the physical activity of assisted-living residents can slow down this referral.

International PA guidelines for older adults recommend being physically active at least 150 minutes a week at a moderate intensity. Deconditioned older adults are advised to start with a low training volume, which should gradually increase and they should be as physically active as their abilities and conditions allow (Chodzko-Zajko et al., 2009; Medicine, 2013; Nelson et al., 2007). Furthermore, guidelines typically prescribe both cardiovascular and muscle-strengthening exercise in order to improve physical functioning. However, old-old adults have such a low level of physical capacity and muscular strength that cardiovascular exercise might provide a stimulus that is sufficiently high to induce positive effects on both cardiovascular capacity as well as muscular strength (Fisher and Steele, 2014). Ergometer-cycling is particularly attractive as training modality for those individuals, considering that it is safe, easy to perform, has limited impact on the joints and does not require as much postural control as walking or cycling outside (Bouaziz et al., 2015). But more research is necessary in this functionally limited age category.

Traditional PA interventions consist of structured training programs under the strict supervision of a coach. The coach systematically prescribes exercise according to the principles of training progression – i.e., with an attainable exercise load (i.e., intensity and volume) and sequence that results in optimal physical responses. Such interventions have the advantage that the coach provides and promotes a structure in exercise that is optimal to achieve the desired adaptive physical outcomes. Previous reviews have indicated that such structured PA interventions can be effective among (community-dwelling) older adults. However, their effects tend to be small and short-lived (Chase, 2014; Conn et al., 2003; van der Bij et al., 2002). In addition, implementation possibilities of these strictly supervised interventions are limited because they require a lot of organization, time and financial support.

In order to facilitate large-scale implementation, procedures to promote PA should consider less demanding forms of supervision, such as supervision with minimal contact moments between coach and participants. To optimize the long-term effectiveness of this approach, it is crucial to base the intervention on validated assumptions of motivation theories, such as the Self-Determination Theory (SDT) (Deci and Ryan, 1985; Ryan and Deci, 2000). The SDT proposes that individuals' motivation to exercise is of better quality when it originates from a more self-inherent appreciation of exercise involvement. Individuals would be more likely to *want to* exercise when this is in line with their personal preference (i.e., autonomy), because they feel or think that this is effective in achieving outcomes that they self-inherently value (i.e., competence), including feeling positively connected to others (i.e., belongingness). Exercise environments that facilitate 'autonomous' exercise motivation, as opposed to controlled motivation, have been shown to yield better long-term exercise involvement (Ryan and Deci, 2000; Teixeira et al., 2012). An autonomy-supportive approach has been found to be effective in promoting PA among (community-dwelling) older adults (Van Hoecke et al., 2014). The question remains whether it can also provide a valuable framework to promote PA among assisted-living facilities, where residents are often older and more dependent on others compared to community-dwellers. In other words, the feasibility of exercise trials with autonomy-supportive, minimal contact supervision is yet to be determined among assisted-living residents.

Previous exercise feasibility trials in similar settings required either strict supervision and/or relatively expensive equipment (Alvarez-Barbosa et al., 2014; Bossers et al., 2014; Fien et al., 2016; Hassan et al., 2016; Sievanen et al., 2014). Strict supervision requires a lot of organization, time and financial support, which ultimately limits large-scale implementation given that financial resources for physical activity are often restricted (Hanson et al., 2014). Therefore, our study evaluated the feasibility of an easy-accessible inexpensive ergometer-cycling program with either autonomy-supportive, minimal contact supervision (AUT) or traditional strict supervision by a coach (STRICT) among old and old-old adults in assisted-living residences. In addition, the effectiveness of the two ergometer-cycling interventions on PA, muscular strength, functional performance and quality of life was investigated. We hypothesized that both interventions would be significantly more effective at improving PA, muscular strength, functional performance and quality of life compared with a control condition (CON). In addition, we hypothesized that STRICT would result in higher adherence rates than AUT in the short-term, while AUT would result in higher long-term adherence rates due to the provided autonomy support.

2. METHODS

2.1. Trial design

This cluster-randomized controlled trial was designed as a parallel-group study, with two different ergometer-cycling interventions and one control condition. The intervention duration was 10 weeks, followed by a 6-month follow-up. Baseline, post-intervention and follow-up measurements were performed from January to March 2013, from April to June 2013, and from October to December 2013 respectively.

2.2. Participants

In 8 assisted-living residences in Flanders (i.e., Dutch-speaking region of Belgium), 417 residents were personally contacted to participate in the study (September – December 2012). These residents lived in independent units, but they were offered a considerable range of supportive services (i.e., provision of meals, house-cleaning, etc.). The exclusion criteria were (1) cognitive impairment as diagnosed by the general practitioner, (2) any specific contra-indication for participation in the ergometer-cycling training program or in the measurements (i.e., severe thrombotic or neurological disease; recent cardiovascular event or serious lung-, heart- or vascular disease; uncontrolled hypertension or diabetes type-II, infection, or tumor; major bone fracture in the past 4 months), and (3) involvement in a structured PA program in the last three months. The selection procedure was approved by the Ethics Committee of the Group Biomedical Sciences of KU Leuven. Ninety-five residents met the eligibility criteria and signed an informed consent.

2.3. Randomization

Randomization took place at the level of the assisted-living residence to minimize contamination between interventions. Given that a lower drop-out can be expected in the control condition as compared to the intervention conditions, allocation ratio was 3:3:2. After stratification for the number of residents, the 8 residences were allocated to one of the three conditions by drawing straws (independent researcher). The conditions were: (1) ergometer-cycling with strict supervision (STRICT; N = 3, n = 35), (2) ergometer-cycling with autonomy-supportive minimal contact supervision (AUT; N = 3, n = 36), or a control condition (CON, N = 2, n = 24). Participants were blinded to group assignment.

2.4. Sample size

Power analysis for repeated measures ANOVA, within-between interaction was performed a priori by means of G*Power 3.1.6. A medium partial eta-squared (0.06) was assumed. The analysis suggested that a total sample size of 51 was required to achieve power of 0.95, which corresponds to 17 subjects per group. Anticipating on a 25% drop-out in the intervention groups and a 15% drop-out in the control group for each time-frame (pre-post and post-follow-up), we concluded that 34 subjects in each intervention group and 24 in the control group would be sufficient.

2.5. Intervention

The intervention in STRICT and AUT comprised a 10-week structured ergometer-cycling training program. For each participant in both intervention groups, initial training volume was individualized based on an ergometer-cycling test. Participants were instructed to pedal for 6 minutes on a stationary bicycle (Kettler® Polo M, Heinz Kettler GmbH & Co, Germany) at a fast but sustainable pace. They were permitted to slow down or to take a rest period if needed, but were instructed to select a speed that they expected to be able to maintain for 6 minutes. Upon cessation, their perception of physical exertion was assessed using the Borg scale (6 to 20). Based on the reported physical exertion (intensity) and on the total minutes of pedaling (volume) during the test, initial training volume was calculated as shown in Table 1. Participants who were not able to cycle for 6 minutes non-stop started with a training volume of maximum 4 minutes of non-stop cycling, regardless of their RPE, which could have been influenced by the duration of the rest periods.

Insert Table 1

Training programs consisted of three moderate-intensity ergometer-cycling sessions per week. In the initial conditioning stage of an exercise program, the volume of exercise should be gradually built up before training intensity increases (Medicine, 2013). Therefore, two minutes per training session were added to the training volume of the next week when the participants indicated that the exercise intensity of the last training week was rather “light” or less (i.e., Borg scale score ≤ 11). A self-reported physical exertion of 11 is assumed to correspond with a heart rate reserve of 50%, which is recommended by the American College of Sports Medicine (ACSM) as the lower intensity threshold for aerobic exercise to have beneficial effects on fitness (Medicine, 2013). The program was designed to optimize feasibility, to facilitate self-administration and to maximize the chances of long-term adherence in deconditioned and frail older subjects.

The ergometers were placed in a common use area of the assisted-living residence to ensure access to all of the study participants in the intervention groups. The control group did not receive PA instructions and no ergometers were available in any common room in their residential home.

2.6. Supervision

In the STRICT group, all training sessions were scheduled for each participant and the training volume was strictly monitored by a qualified coach, who supervised all sessions. This coach was a Health Fitness Specialist (MSc in Kinesiology, specialization in health-related physical activity counseling) and acted as the participant’s personal trainer. The minimal contact supervision of the AUT group consisted of a limited number of contact moments (i.e. four 1-hour contacts in 10 weeks) between the same qualified coach and the participant. Contact moments took place two to three weeks after the previous contact. An easily accessible individualized ergometer-cycling program consisting of weekly schedules was provided to the participants. Training volume was similarly prescribed as for STRICT and the coach suggested a training frequency of 3 times weekly, on nonconsecutive days. During the first face-to-face contact, the coach explained the individualized program. During the other contact moments, the degree of adherence to the program was evaluated and the coach identified barriers and suggested solutions. The coach motivated the participants to persist in the program by coaching according to the principles of the SDT.

In both STRICT and AUT, the coach tried to create a need-supportive environment: by providing competence support (e.g. positive feedback, encourage participants to progress through the different week schedules according to their individual abilities) and by providing belongingness (e.g. active listening, encouraging exercising with peers). In AUT, the coach additionally stimulated autonomy (e.g. letting the participants make decisions, counteract dependency from coach to make participants self-supportive). More specifically, participants in AUT had to perform the program on their own and they could choose when and with whom they exercised.

2.7. Follow-up period

After the 10-week intervention, the ergometer remained available in the residences of the intervention groups and participants were encouraged to continue their individualized ergometer-cycling program. To avoid any interference, no contact took place between coach and participants between post- and follow-up tests.

2.8. Outcome measurements

Participants completed measurements before (pre), immediately after the intervention (post, 10weeks) and 6 months after post-test measurements (follow-up). All measurements took place at the assisted-living facility on two testing days. Usual walking aids were allowed for all tests.

2.8.1. *Feasibility*

In accordance with previous research, the feasibility of each intervention was assessed by the following criteria: recruitment rate, number of drop-outs, exercise session adherence, acceptability and adverse events (Bossers et al., 2014; Fien et al., 2016). Recruitment rate was calculated as the number of residents recruited from those who were invited to participate. To evaluate exercise adherence, all participants in STRICT and AUT were asked to record their training frequency and volume during the 10-week intervention and between post- and follow-up tests. Adherence rates were calculated as the number of training sessions performed divided by the recommended training frequency and multiplied by 100. Frequency recommendation from pre to post was 30 (3x/week for 10 weeks), and from post to follow-up 72 times (3x/week for 6 months). Participants who adhered to at least 80% of the recommended training sessions were defined as high-adherers. Participants who adhered to less than 80% of the recommended training sessions were defined as low-adherers. The number of drop-outs was recorded, including the reason for drop-out. Acceptability was measured via a short survey completed after the 10-week intervention. This survey evaluated the feelings related to exercise in the participants of STRICT and AUT. The following questions were asked on a 7-point Likert scale (ranging from 0 = 'not at all…' to 7 = 'very…'): (1) How much did you enjoy the ergometer-cycling program? (2) How feasible was the ergometer-cycling program for you? In addition, all participants of STRICT and AUT were asked to report any adverse events during the intervention.

2.8.2. *Physical activity*

Both objective and self-reported PA measurements have been found to be valid and reliable among elderly. However, both measurements have some disadvantages as objective measurements cannot measure all types of activity (such as swimming), and self-reported PA is influenced by memory recall, and combining the two measurements is recommended to obtain the most accurate data on PA levels (Colbert et al., 2011).

Self-reported PA, expressed in minutes/week, was measured with an interview-assisted modified version of the Physical Activity Scale for Elderly (Washburn et al., 1993). Participants were asked to recall the number of days per week and the number of hours per day they had spent in light- (e.g. slow walking [during leisure time and for transportation], exercises at home), moderate- (e.g. cycling, swimming, gardening) and vigorous-intensity (e.g. running) PA in a typical week during the past month (for pre and follow-up) or in the week after the last training session or 10-week control period (post).

The wireless monitors SenseWear Pro (SWPro) and Mini (SWMini) (Bodymedia Inc., Pittsburgh, PA, USA) were used to estimate energy expenditure (EE; expressed in kcal/min). The SenseWear is a valid tool among older adults (Colbert et al., 2011). Participants were randomly given a SWPro or SWMini because of practical reasons, except those participants that had a cardiac pacemaker (n = 10). To avoid interference with the pacemaker, participants were given a SWPro when the cardiac pacemaker was inserted in the left subclavicular region, as the SWPro is worn over the right triceps. Participants having a pacemaker inserted in the right subclavicular region were given a SWMini, worn over the left triceps. The monitor estimates EE minute-by-minute through automatically applied algorithms developed by the manufacturer. Participants were instructed to wear the device for 24 hours on 7 consecutive days (except during bathing activities). A valid day was considered as a day with at least 1368 min of SW data, which corresponds to a wearing time of 95%. Days below that threshold were excluded from analyses. Analyses showed a significant difference in EE between Sunday and the other days of the week ($p < 0.05$). Therefore, in order to be included in the analyses, participants needed valid data of Sunday and at least 3 other days.

2.8.3. Muscular strength

Isometric knee extension strength was measured using a digital Kern HCB dynamometer. Participants were seated on an adjustable chair with the knee and hip joint angles at 90°. The upper legs were stabilized with a safety belt. The dynamometer was attached to the rear leg of the chair and to the distal end of the tibia, using a strap perpendicular to the ground. The participants had to extend their leg as hard as possible against the strap (Martien et al., 2015). The right leg was tested, unless there was a medical contraindication (knee or hip prosthesis). The test was performed twice, and the highest score (in kg) was recorded for further analysis. Previous research in our lab showed a high test–retest reliability for this field test in older adults (ICC = 0.91–0.95) (data not published).

2.8.4. Functional performance

Functional performance was assessed by means of the 6-minute walk test (6MWT), which has been shown to be a good indicator of functional performance in older adults (Bean et al., 2002). However, it only includes walking ability. Therefore, we additionally included the modified physical performance test (mPPT), a functional test battery that covers a broader range of functional items. The 6MWT was performed over a walking course of 20m. Participants walked up and down the course at a fast but comfortable pace, and the distance covered in 6 minutes (6MWD, in m) was recorded (Society, 2002). The mPPT consists of nine functional items related to daily activities: (i) lifting a book, (ii) putting on and taking off a coat, (iii) picking up a penny, (iv) turning 360°, (v) the 5x chair rise test, (vi) ascending one flight of stairs, and (vii) climbing four flights of stairs, (viii) walking 15 m and (ix) the progressive Romberg test for balance (5). The score of each item ranges from 0 (the inability to complete the task) to 4 (the highest level of performance), with a total mPPT-score of maximum 36 points.

2.8.5. Quality of life

Social, physical and psychological well-being was assessed with 15 items of the Marcoen scale for subjective well-being (5 items per category) (Marcoen et al., 2002). The questionnaire was interview-assisted. Participants had to indicate how often they felt as stated in each item (e.g., “I am able to deal with my current life situation”) on a 7-point Likert scale, ranging from (1) never to (7) always. Well-being was calculated as the mean score of all 15 items. The scale was internally consistent, with Cronbach’s α of 0.87 at pre-, 0.88 at post- and 0.90 at follow-up test.

2.9. Statistical methods

Data were analyzed using SPSS software version 22.0 (Chicago, IL). For all analyses, the significance level was set at $p < 0.05$. Descriptive statistics were presented as means ± SD. A chi-square test or Fisher’s exact test (when >20% of cells have expected counts of less than 5) was used to test for differences in drop-out rates and in number of adherers between the groups. The Fisher’s exact test was also used to check for differences between the percentages of participants in the STRICT and AUT reporting that the cycling program was fun and/or feasible. Between-group differences for baseline and outcome variables were analyzed by one-way analysis of variance with Bonferroni post-hoc testing. Within-group changes from pre to post, post to follow-up and from pre to follow-up for all outcome variables were analyzed with paired T-tests. To assess between-group differences in changes over time for all outcome variables, linear mixed-model analyses with an unstructured covariance structure (time as repeated factor and group as fixed factor) were used. Post-hoc analyses were conducted to determine differences in changes between groups.

3. RESULTS

3.1. Sample characteristics and recruitment rate

Among the 417 contacted residents, 25% were not interested in participation and 53% were excluded in accordance with the exclusion criteria (Fig. 1). In total, 95 residents consented to participation after receiving information about the content of study participation. Baseline characteristics are reported in Table 2. No significant baseline differences were detected between the three groups for any of the variables (all $p > 0.05$), although a trend was shown for a higher well-being in CON as compared to STRICT ($p = 0.057$) and AUT ($p = 0.075$).

Insert Table 2

3.2. Drop-out and adverse events

The number of and the reasons for drop-outs are shown in Fig. 1. Chi-square analysis showed that the drop-out rates were not significantly different between the three groups. There was a drop-out of 12.63% from pre to post and of 9.64% from post to follow-up. The most frequently reported reason was a health problem. Drop-out analyses revealed significant baseline differences between participants who completed post-tests and drop-outs. Drop-outs scored significantly lower for 6MWD ($p = 0.003$), mPPT ($p = 0.003$) and for knee extension strength ($p = 0.030$). Moreover, participants who dropped out at follow-up were older ($p = 0.033$) and more functionally dependent (mPPT; $p = 0.008$) than those who completed follow-up. Adverse effects included breathing difficulties (5 participants in STRICT, 1 in AUT), knee pain (6 participants in STRICT, 1 in AUT), saddle-soreness (3 participants in

STRICT, 0 in AUT), hip pain (1 participant in STRICT, 0 in AUT), sore leg muscles (7 participants in STRICT, 0 in AUT) and lower back pain (3 participants in STRICT, 0 in AUT). However, these adverse effects did not result in drop-outs.

Insert Fig. 1

3.3. Adherence

Table 3 shows the adherence to the ergometer-cycling program for participants who completed the 10-week intervention period. In total 27 participants of the STRICT group were high-adherers, and 11 participants of the AUT were regarded as high-adherers. This number of high-adherers was significantly higher in STRICT compared with AUT (84.4% versus 37.9% respectively, $p < 0.001$). During the intervention period, the STRICT group exercised more in comparison with the AUT group (adherence rate: $p = 0.001$; total cycling minutes: $p = 0.006$; sessions per week: $p = 0.001$; minutes per session: $p = 0.021$).

Insert Table 3

After the intervention period, adherence rate and training frequency significantly decreased in both groups, with no difference between STRICT and AUT. However, 56.7% of STRICT and 60.0% of AUT continued to cycle on the ergometer with an adherence rate of at least 20% (15 training sessions over 6 months). Moreover, 26.7% (8 out of 30 participants) and 20.0% (5 out of 25 participants) of STRICT and AUT respectively had a high adherence rate ≥80% during follow-up period. Interestingly, cycling minutes per session significantly increased from pre to follow-up in both intervention groups. Participants in STRICT had a longer training duration per session during follow-up period in comparison with AUT ($p = 0.001$), even though total cycling minutes did not differ significantly between groups (p = 0.199) (Table 3).

3.4. Acceptability

A majority of the participants in both STRICT (93.8%) and AUT (82.8%) considered the cycling program as 'fun' (5 on Likert scale) or 'very much fun' (6 or 7 on Likert scale). Moreover, a majority in both groups indicated that the cycling program was feasible for them (96.9% of STRICT group and 89.7% of AUT group, 5-7 on Likert scale). No significant differences emerged between the participants in the STRICT and AUT condition with regard to the percentage of participants who indicated that the ergometer program was fun (p = 0.241) or feasible (p = 0.338).

3.5. Physical activity

3.5.1. Self-reported PA (Table 4)

Neither a time nor a time-by-group interaction effect was found for self-reported light-intensity PA. However, a significant time-by-group interaction effect emerged for moderate-intensity PA (p = 0.034). More specifically, from pre to post, STRICT and AUT increased significantly more in comparison with CON (p = 0.019 and p = 0.010 respectively). Moreover, paired t-tests showed a significant increase in self-reported moderate-intensity PA from pre to follow-up for STRICT (p = 0.014) and a trend toward a significant increase for AUT (p = 0.055). None of the residents participated in vigorous-intensity PA.

Insert Table 4

3.5.2. Objectively measured PA (Table 4)

Approximately 80% (75 out of 95) of the participants had complete SenseWear-data at baseline. Complete datasets were available for 47 and 38 participants at post- and follow-up test respectively. A significant time-by-group interaction effect was found for total EE, with a higher increase from pre to post in AUT compared to CON (p = 0.020). However, this difference disappeared at follow-up.

3.6. Muscular strength and functional performance

No significant time-by-group interaction effects were found for knee extension strength, 6MWD or mPPT. Paired t-tests only revealed a significant decrease from pre to post in knee extension strength (-5.58±3.96%; p = 0.043) in the CON group and a significant increase from pre to post in 6MWD (+11.70±5.70%; p = 0.024) and mPPT (+5.77±2.54%; p = 0.042) in the STRICT group. These changes were no longer significant at follow-up (Table 4).

When comparing high-adherers with low-adherers, a significant time-by-group interaction effect was found for mPPT (p = 0.047) and a trend towards a significant time-by-group interaction effect was found for knee extension strength (p = 0.054) (Table 5). More specifically, high-adherers showed a greater increase from pre to post for mPPT, whereas low-adherers showed a greater decrease from pre to post for knee extension strength.

Insert Table 5

3.7. Quality of life

No significant time-by-group interaction effect was found for well-being. Paired t-tests only revealed a significant increase from pre to post in well-being (p = 0.039) in the STRICT group. This change was no longer significant at follow-up.

When comparing high-adherers with low-adherers, a significant time-by-group interaction effect was found for well-being from pre to post (p = 0.000) and from post to follow-up (p = 0.040) in advantage of the high-adherers. Paired t-tests showed a significant increase in well-being from pre to post for high-adherers (p = 0.001). This change did not remain significant after follow-up.

4. DISCUSSION

The purpose of the present study was to examine the feasibility and short- and long-term effectiveness of a 10-week ergometer-cycling intervention on PA, muscular strength, functional performance and quality of life in older adults living in assisted-living residences. Two coaching procedures were compared: (1) strictly supervised coaching and (2) autonomy-supportive coaching with a limited number of contact moments between coach and participant. This study showed that an ergometer-cycling program with minimal or strict supervision of a coach is feasible among older assisted living residents. When adherence to the program is sufficiently high, positive but small effects can be expected on functional performance, well-being and muscular strength.

A first important outcome to assess the feasibility of an exercise trial is recruitment rate. Of the total population of 417 residents, 260 were identified as being potentially eligible to participate in an ergometer-cycling program (62% of the total population). However, 62 of them (15% of the total population) were excluded from our study because they were already exercising on a bike, which would confound our findings. Other residents that were excluded either had physical problems (127) or mental problems (30). Eventually, 23% (95 out of 417) of the total population consented to participate. Taking into account those residents who were willing to participate but who were excluded because of their exercise behavior (15%), our recruitment rate (23% + 15%) was comparable with or even higher than previous exercise trials in similar populations (Bossers et al., 2014; Cyarto et al., 2008a, b; Fien et al., 2016).

A second feasibility outcome is exercise adherence. Adherence rates during the intervention were high in both intervention groups, i.e. 89% in STRICT and 68% in AUT. In addition, 84% of participants in STRICT and 38% of participants in AUT attended at least 80% of the exercise sessions. This high attendance rate in STRICT is similar to or higher than in previous exercise feasibility trials in similar settings (Alvarez-Barbosa et al., 2014; Bossers et al., 2014; Fien et al., 2016; Hassan et al., 2016; Henwood et al., 2015). Even though attendance rates were markedly lower in AUT, they were still higher than in some previous exercise trials (Hassan et al., 2016; Henwood et al., 2015). In contrast with previous feasibility trials in similar settings, our study also included information on long-term adherence rates after the end of the intervention period. Interestingly, more than half of the participants of the intervention groups continued cycling to some extent after the supervised intervention. Even more, 20.0% to 26.7% of the participants had a long-term adherence rate of ≥ 80%. The average long-term adherence rates were 44% and 43% for participants in STRICT and AUT respectively, which are comparable to or higher than long-term adherence rates in a previous study of Cyarto and colleagues. In their study, adherence rates were compared between a home-based intervention approach and a group-based strictly supervised intervention approach among older adults living in retirement villages. The intervention consisted of a combination of strength and balance exercises. Participants in the home-based intervention were supervised through a limited number of contact moments (face-to-face or telephone calls) with a trained instructor (Cyarto et al., 2006). Their approach was very similar to the present approach used in AUT. The finding that the long-term adherence rate in AUT was higher compared with the home-based intervention of Cyarto et al. (43% versus

21%) underlines the feasibility of our ergometer-cycling program with minimal contact supervision (Cyarto et al., 2006).

The feasibility of the training program was further demonstrated by participants' perceptions of the exercise sessions. More specifically, the training program was experienced as feasible and pleasant by the majority of participants. As a consequence, almost all facilities (STRICT and AUT) decided to purchase a cycle ergometer after the end of the study. Adverse events were limited to perceptions of mild discomfort that are frequently reported during exercise, such as saddle- and leg-soreness, knee, hip or lower back pain and breathing difficulties. It should be noted that none of these adverse events resulted in drop-outs. More adverse events were reported in STRICT as compared to AUT, but this might be a consequence of the presence of the personal trainer at each training session, who repeatedly asked the participants to report any adverse events. This might have resulted in an over-reporting of adverse events, including every minor discomfort. The number of drop-outs remained limited in both intervention groups (<20%) and reasons for drop out were not related to the training program. In conclusion, these results further suggest that a cycle ergometer is a safe and feasible training tool in this population, with potential for large-scale implementation. Even with minimal contact supervision, adherence rates were considerably high, the program was perceived as fun and feasible, and adverse events and drop-outs remained limited.

Next to the feasibility, we aimed at evaluating the benefits of our ergometer-cycling program. The current ergometer-cycling program does not seem to be a sufficient stimulus to increase muscular strength, functional performance and quality of life in the short- or long-run. However, when comparing the results of participants with a high adherence to participants with a low adherence, positive effects occurred. Participants with a high adherence seemed to be able to counteract declines in muscular strength compared to low-adherers in the short-term, although this trend did not reach statistical significance (p = .054). This result is in line with previous research that reported a significant increase in leg strength after a cycling intervention in older adults (Buchner et al., 1997; Harber et al., 2009; Lovell et al., 2010). Moreover, high-adherers showed a higher overall score on the mPPT in the short-term as compared to low-adherers, increased their 6-minute walk distance and reported an improvement in their quality of life. This finding corroborates previous research showing the effects of ergometer-cycling programs on functional performance in older adults (Denison et al., 2013; Lee and Cho, 2014; Mangione et al., 1999).

Based on the abovementioned effects, it can be concluded that the ergometer-cycling program has the potential to slow down the physical disablement process and to improve well-being at age, but only when adherence is sufficiently high. However, it should be acknowledged that a mean increase of 13.95m on the distance covered during the 6MWT was rather limited. Previous research indicated that an increase of 50m is needed to be clinically relevant (Morley et al., 2011). Nevertheless, clinically relevant improvements on the 6MWT were found in 21.1% of high-adherers and 13.2% of high-adherers could be classified in a better mPPT category post- as compared to pre-intervention, which represents a clear improvement in their physical frailty status.

Another main interest of this study was potential differences in adherence rates and in involvement in PA during and after our two intervention strategies. Here, we had hypothesized that the autonomy-supportive coaching strategy (AUT) would yield larger long-term effects on PA in comparison with STRICT, even though strict supervision would probably result in better adherence in the short term. As expected, strict supervision resulted in higher adherence rates and higher training volume (total cycling minutes and minutes per session) during the 10-week intervention. Even though the coach encouraged all participants in STRICT and AUT to progressively increase training volume over the 10 weeks, this message might have had more impact when the personal trainer was present at every exercise session. This is in line with the findings of Cyarto and colleagues. In their study, participants in a group-based supervised exercise program were more compliant to exercise progression compared with participants in a home-based exercise program. In the latter group, there was less face-to-face contact with the instructor and thus fewer opportunities for the instructor to encourage participants to progress in the exercises (Cyarto et al., 2006; Cyarto et al., 2008a, b). Interestingly however, and in contrast to the adherence rates during our intervention, objectively measured overall energy expenditure appeared to increase more in AUT in the short term. Even though these findings could not be confirmed through questionnaire-based PA measurements, they seem to suggest that AUT increased the level of PA outside of the cycling program more than STRICT in the short-term.

Contrary to our hypothesis, neither long-term adherence to the program, nor long-term involvement in PA was higher in AUT as compared to STRICT. Even more, cycling duration per session during follow-up was higher in STRICT (20.50±8.18 minutes vs. 12.84±5.88 minutes), although total cycling minutes did not differ between the two groups. Thus, the autonomy-supportive coaching strategy did not result in long-term PA engagement after the intervention period in assisted living residents, which is in contrast with previous research in community-dwelling older adults (Opdenacker et al., 2008; Van Hoecke et al., 2014). It could be that older adults living in residential homes, and who are probably coping with limitations in daily functioning, have other concerns than community-dwelling older adults. Such concerns might include the fear for exhaustion or the desire to be assisted when using the ergometer. Because of their increasing physical uncertainty, older adults in residential homes might be less inclined to do the exercises on their own without supervision. In agreement with this statement, the importance of supervision for less able older adults has been underlined in previous research. More specifically, Cyarto et al. showed that participants with reduced functional ability were more likely to drop out when strict supervision was no longer provided (Cyarto et al., 2006). Consequently, older adults in residential homes might value the fulfillment of their need for autonomy less than the fulfillment of their need for competence and belongingness. It would be interesting to investigate the relative importance of the three needs proposed by SDT among this specific population in order to develop more effective and sustainable coaching strategies.

We acknowledge that the present study has a number of limitations. First, there might be a lack of statistical significance due to the wide variation in performances of older adults. A second limitation concerns the drop-out. It remains unclear whether missing data at follow-up has influenced the findings, as participants who dropped out at follow-up were older and more functionally dependent than those who completed follow-up. However, this observation is not new. In previous research, it has already been shown that the oldest participants with the poorest physical function are most at risk for a drop-out (Cyarto et al., 2006; Tiedemann et al., 2011). Third, not all participants had complete data for objectively measured activity.

Nevertheless, this study also had some specific strengths. To our knowledge, this is the first study investigating the effects of an ergometer-cycling intervention with different types of supervision among elderly in assisted-living facilities. The sample was considerably older than in previous ergometer-cycling interventions in older adults (Bouaziz et al., 2015; Buchner et al., 1997; Denison et al., 2013; Harber et al., 2009; Lee and Cho, 2014; Mangione et al., 1999). Participants were recruited by use of a door-to-door strategy, which is considered to be a direct recruitment strategy. Thus, participants did not have to respond to an advertisement or newspaper, but were convinced through face-to-face contact. Although this door-to-door approach requires much time and patience, it increases the probability that the less motivated and mobility-limited elderly participate in the study. This recruitment strategy improves the generalizability of the findings to other assisted-living residents. Another strength was that the intervention was embedded in the existing structures of the assisted-living facilities. Ergometers were placed in a common area (e.g. cafeteria), and were therefore accessible to all residents. In addition, the effects on PA were evaluated with both self-reported and objective measures. Only few intervention studies using objective monitoring have been conducted in older adults (Strath et al., 2012). Subjectively and objectively measured PA can differ substantially, as demonstrated in the present study, and therefore only measuring one of both does not provide the whole picture.

5. CONCLUSION

The findings of the present study show that both interventions increased PA during the 10 week intervention phase and across the six month follow up, irrespective of the type of supervision provided during the study. When adherence to the program is sufficiently high, positive but small effects can be expected on functional performance, well-being and muscular strength. Even though autonomy support in this age-group does not result in better long-term adherence rates, an ergometer-cycling program with minimal supervision according to the SDT seems a feasible intervention to be applied in residential homes. However, the presence of a coach during exercise has a clear impact on the training adherence and volume, but the cost-effectiveness of both supervision strategies should be investigated in future research. In addition, future studies should focus on how to further increase long-term adherence, for example by means of e-tools.

Conflict of interest statement

The authors declare that they have no conflicts of interest.

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Trail registration

Clinical Trials NCT01748461.

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Table 1

Calculation of initial training volume (minutes/session).

INITIAL TRAINING VOLUME		
Initial ergometer-cycling test		Training volume per session week 1
6 minutes	Borg < 11	6 + 4 minutes
	≥11 Borg <13	4 + 4 minutes
	Borg ≥13	4 + 2 minutes
<6 minutes	≥3 minutes	4 + 2 minutes
	≤3 minutes	2 + 2 minutes

Table 2

Baseline characteristics of the three groups, expressed as means and SD or percentage.

		Total (N=95)		STRICT (n=35)		AUT (n=36)		CON (n=24)	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Age (years)		82.12	5.92	81.49	5.78	81.57	6.76	83.88	4.46
Gender (% females)		76.84		68.57		80.56		83.33	
Body Mass Index (kg/m^2)		28.82	4.56	28.53	4.43	29.46	4.53	28.28	4.87
6MWD (m)		269.44	106.91	267.74	121.92	264.69	107.87	279.04	83.05
mPPT (/36)		26.82	6.98	27.26	6.79	26.33	6.81	26.92	7.74
	Not frail (>31)	31.6%		34.3%		27.8%		33.3%	
	Mildly frail (25-31)	33.7%		31.4%		36.1%		33.3%	
	Moderately frail (17-24)	26.3%		25.7%		27.8%		25.0%	
	No longer independent (<17)	8.4%		8.6%		8.3%		8.3%	
Knee extension strength (kg)		21.69	8.83	22.23	9.24	21.78	9.92	20.76	6.47
Moderate-intensity PA (min/week)		8.16	39.59	5.57	30.46	14.17	55.77	2.92	14.29
Well-being (1 < score < 7)		5.53	0.80	5.39	0.83	5.42	0.84	5.88	0.57

Note. Abbreviations: 6MWD=6 minute walk distance; mPPT=modified Physical Performance Test, PA= physical activity (self-reported); STRICT=strictly supervised by coach; AUT=autonomy-supportive, minimal coaching contact; CON=control group

Table 3

Cycle ergometer use during the 10-week intervention period and during the 6-month follow-up period for both intervention groups.

		10-week period between pre and post				6-months period between post and follow-up				t-value
		N	*Mean*	±*SD*	*Min – Max*	*N*	*Mean*	±*SD*	*Min – Max*	
STRICT	Adherence rate (%)	32	89.17§	13.14	40.00 – 100.00	30	44.12	42.41	0.00 – 119.44	6.12**
	Total cycling minutes	32	354.72§	139.58	96.00 – 674.00	30	722.70	828.37	0.00 – 2280.00	
	Exercise sessions per week[a]	32	2.68§	0.39	1.20 – 3.20	21	1.89	1.11	0.17 – 3.58	3.59*
	Minutes per session[a]	32	13.04§	4.23	5.57 – 23.24	21	20.50§	8.18	6.00 – 30.53	–4.92**
AUT	Adherence rate	29	68.16	31.29	13.33 – 130.00	25	42.89	48.78	0.00 – 200.00	3.33*
	Total cycling minutes	29	237.84	178.71	22.00 – 656.00	25	451.96	690.45	0.00 – 3218.00	
	Exercise sessions per week[a]	29	2.04	0.94	0.40 – 3.90	20	1.61	1.47	0.13 – 6.00	2.51*
	Minutes per session[a]	29	10.55	3.96	4.96 – 18.22	20	12.84	5.88	4.00 – 25.00	–2.24*

STRICT=strictly supervised by coach; AUT=autonomy-supportive, minimal coaching contact

[a] Mean values for those participants who exercised on the cycle ergometer. During the 10-week intervention period, all participants exercised to some extent. This was not the case for the 6-month follow-up: 14 individuals (9 in STRICT, 5 in AUT) did not cycle at all and were therefore not included in the calculation of 'exercise sessions per week' and 'minutes per session'.

* Significant difference between the 10-week and 6-month period (* $p < 0.05$; ** $p < 0.001$)

§ Significant difference with AUT ($p < 0.05$)

Table 4

Estimated means (SE) at pre, post and follow-up for the three groups for physical activity behavior, muscular strength, functional performance and well-being.

	Pre	Post	Follow-up	F-value time (*p*-value)	F-value time x group (*p*-value)
			Self-reported PA		
Light-intensity PA (min/week)					
STRICT	346.19 (58.15)	327.35 (48.70)	362.24 (59.23)		
AUT	285.17 (57.09)	224.93 (49.34)	292.23 (60.63)	0.81 (0.450)	1.02 (0.403)
CON	158.85 (69.92)	212.70 (58.78)	195.87 (71.80)		
Moderate-intensity PA (min/week)					
STRICT	5.57 (6.61)	43.21 (14.20)*§	27.29 (14.79)†♯		
AUT	14.17 (6.51)	56.76 (14.45)*§	49.06 (15.19)♯	**7.97 (0.001)**	**2.72 (0.034)**
CON	2.92 (7.98)	1.18 (17.13)	7.53 (17.90)		
			Objectively measured PA		
Energy expenditure (kcal/day)					
STRICT	1848.71 (58.79)	1863.67 (57.94)	1818.68 (52.77)		
AUT	1840.76 (56.81)	1921.32 (55.79)*§	1803.84 (52.11)‡♯	**3.32 (0.046)**	**3.26 (0.020)**
CON	1823.69 (69.20)	1755.50 (69.13)	1768.84 (65.42)		
			Muscular strength, functional performance and well-being		
6MWD (m)					
STRICT	267.74 (17.95)	285.36 (18.57)*	281.54 (19.79)		
AUT	264.69 (17.70)	262.78 (18.68)	253.60 (19.85)	1.85 (0.165)	1.22 (0.309)
CON	279.04 (21.68)	282.69 (22.53)	270.64 (24.03)		
mPPT (/36)					
STRICT	27.26 (1.17)	28.49 (1.17)*	27.01 (1.23)‡		

AUT	26.33 (1.16)	26.11 (1.17)	26.20 (1.24)	2.98 (0.057)	1.21 (0.312)
CON	26.92 (1.42)	27.70 (1.41)	26.36 (1.50)		
Knee-extension strength (kg)					
STRICT	22.23 (1.55)	22.26 (1.58)	21.62 (1.70)		
AUT	21.78 (1.53)	21.02 (1.57)	21.43 (1.70)	2.20 (0.119)	0.96 (0.437)
CON	20.76 (1.87)	19.23 (1.90)*	19.64 (2.05)		
Well-being (scale from 1 to 7)					
STRICT	5.39 (.13)	5.65 (.14)*	5.54 (.15)		
AUT	5.42 (.13)	5.35 (.14)	5.27 (.16)	.50 (0.613)	1.40 (0.242)
CON	5.88 (.16)	5.88 (.17)	5.91 (.18)		

Note. Abbreviations: PA=physical activity; 6MWD=6 minute walk distance; mPPT=modified Physical Performance Test

* Significant change from pre to post; †pre to follow-up; ‡post to follow-up ($p < 0.05$)

§ Significant difference in change from pre to post with CON ($p < 0.05$)

¶ Significant difference in change from pre to post with AUT ($p < 0.05$)

♯ Significant difference in change from post to follow-up with CON ($p < 0.05$)

¥ Significant difference in change from post to follow-up with AUT ($p < 0.05$)

Table 5

Means (±SD) at baseline, post and follow-up for muscular strength, functional performance and well-being in high-adherers (adherence rate ≥80%; N=45) and low-adherers (adherence rate <80% and CON group; N=38).

Outcome measures		Pre	Post	Follow-up	F-value time (P-value)	F-value time x group (P-value)
6MWD (m)	High-adherers	293.55 (124.61)	307.50 (17.05)*	301.22 (18.24)	1.46 (0.240)	1.14 (0.324)
	Low-adherers	270.36 (84.08)	270.04 (15.50)	262.49 (16.55)		
mPPT (/36)	High-adherers	27.76 (6.77)	29.21 (1.05)*§	28.04 (1.11)‡	3.04 (0.054)	**3.19 (0.047)**
	Low-adherers	27.15 (6.50)	26.91 (0.96)	26.24 (1.01)		
Knee extension strength (kg)	High-adherers	23.79 (9.06)	23.96 (1.35)§	23.44 (1.48)	1.86 (0.164)	3.04 (0.054)
	Low-adherers	21.28 (7.26)	19.77 (1.27)*	20.37 (1.40)		
Well-being (1 < score < 7)	High-adherers	5.43 (0.13)	5.76 (0.13)*§	5.54 (0.14) ¶	1.14 (0.330)	**6.91 (0.002)**
	Low-adherers	5.64 (0.12)	5.49 (0.12)	5.56 (0.13)		

Note. Abbreviations: 6MWD=6 minute walk distance; mPPT=modified Physical Performance Test.

* Significant change from pre to post; †from pre to follow-up; ‡from post to follow-up ($p < 0.05$)

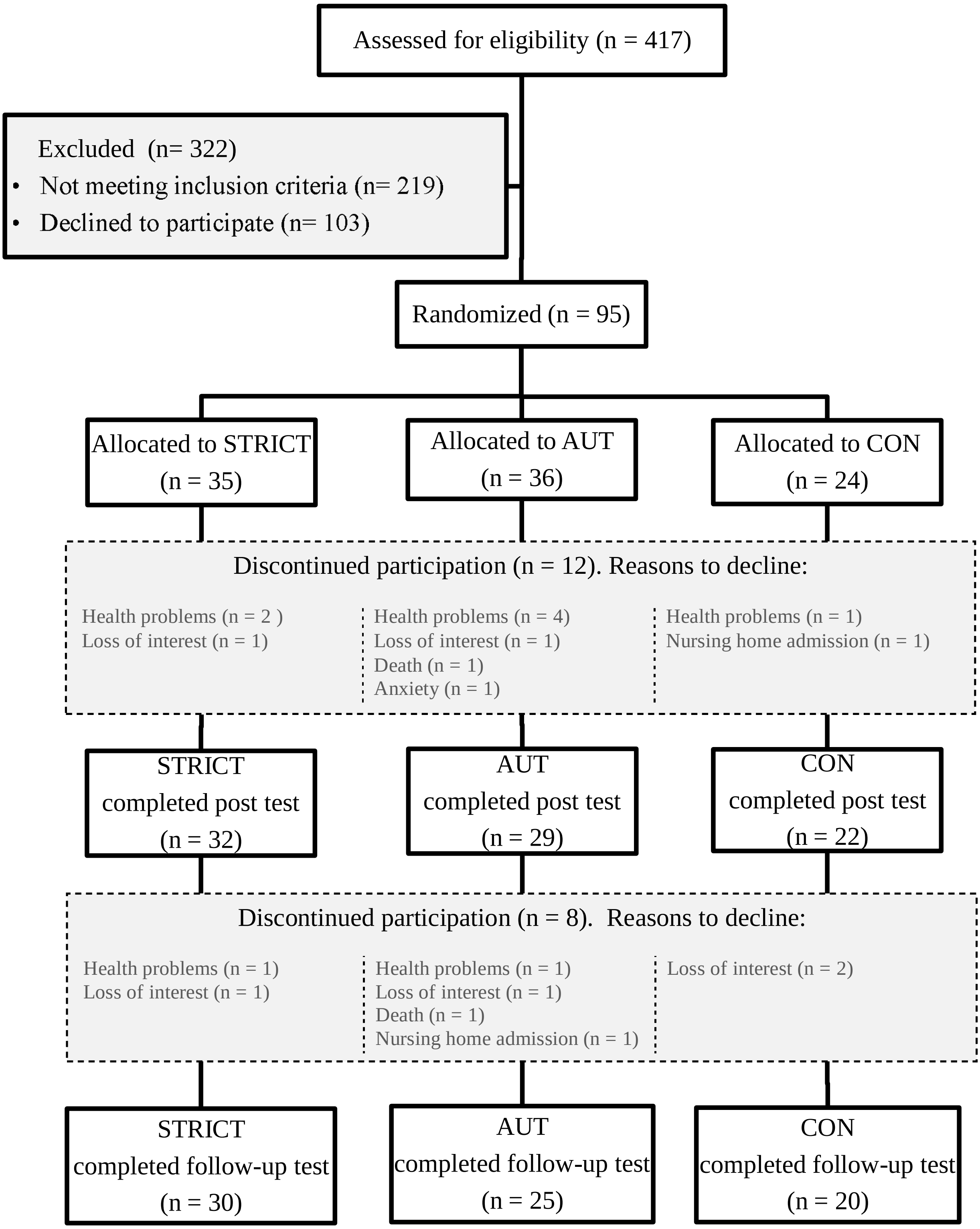
§ Significant difference in change with low-adherers ($p < 0.05$)

¶ Significant difference in change from post to follow-up with low-adherers ($p < 0.05$)

Figure legends

Fig. 1. Flow-chart of participants.

Figure



Assessed for eligibility (n = 417)
Excluded (n= 322)
• Not meeting inclusion criteria (n= 219)
• Declined to participate (n= 103)
Randomized (n = 95)
Allocated to STRICT (n = 35)
Allocated to AUT (n = 36)
Allocated to CON (n = 24)
Discontinued participation (n = 12). Reasons to decline:
Health problems (n = 2)
Loss of interest (n = 1)
Health problems (n = 4)
Loss of interest (n = 1)
Death (n = 1)
Anxiety (n = 1)
Health problems (n = 1)
Nursing home admission (n = 1)
STRICT completed post test (n = 32)
AUT completed post test (n = 29)
CON completed post test (n = 22)
Discontinued participation (n = 8). Reasons to decline:
Health problems (n = 1)
Loss of interest (n = 1)
Health problems (n = 1)
Loss of interest (n = 1)
Death (n = 1)
Nursing home admission (n = 1)
Loss of interest (n = 2)
STRICT completed follow-up test (n = 30)
AUT completed follow-up test (n = 25)
CON completed follow-up test (n = 20)